SHORT-TERM ECONOMETRIC FORECASTING ANALYSIS FOR LATIN AMERICA

BY

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Given the short-term nature, one year or less, of many policy goals espoused by decision makers in Latin America, the objective of this study is to examine the applicability of different forecasting techniques to a subset of short-run economic questions. Because quarterly national income and product series are typically not available, most commercial econometric forecasting analysis for the region is conducted utilizing annual data. Monthly time series do, however, exist for a large number of key macroeconomic and financial variables. It is from the latter group of publicly available data sets that the econometric modeling and simulation exercises are drawn.

Chapter 2 examines potential impacts associated with Colombian monetary authority efforts to cut the rate of inflation by 10 over a 12-month period. Principal tools

relied upon include slower rates of nominal exchange rate devaluation and money supply growth. Empirical analysis in Chapter 2 is carried out utilizing transfer function autoregressive moving average modeling. Model simulations indicate that adherence to such a program can lead to noticeable disinflation over a 24-month period.

Similar to other Latin American economies, Ecuador has faced persistently high rates of inflation in recent years. In May 1994, the government signed a stand-by loan agreement with the International Monetary Fund that established a goal of reducing the inflation rate to 15 percent over a 19-month period. Chapter 3 develops an exchange rate augmented monetary model to assess viability of the price stabilization program. In contrast to the time series approach of Chapter 2, short-run inflationary dynamics are modeled using an econometric framework.

Economic debates regarding Latin America in recent years have been dominated by the debt crisis. In response to debtor country defaults, many lenders reduced or reshuffled risk exposures by selling debt certificates at discounts from face value. Chapter 4 analyzes the predictability of secondary-market debt prices for Colombia, Ecuador, and Venezuela. Estimation is accomplished via generalized least squares over 24 separate historical periods utilizing monthly data. Model simulations indicate that forecasting these prices is a difficult task.

CHAPTER 1
ECONOMETRIC FORECASTING IN LATIN AMERICA

Econometric forecasting analysis began developing as a field of research with the initial endeavors of Jan Tinbergen and others in the 1930s (Dhane and Barten, 1989). These relatively small macroeconometric models of the Dutch economy were developed using annual data. Research on business cycles in the United States began replicating and extending the Dutch modeling examples in the 1940s. Increasing interest in short-term economic fluctuations eventually led to the development of quarterly forecasting models (Barger and Klein, 1954).

Along with the expansion of structural econometric modeling and research with respect to forecasting and policy analysis, time series statistics also became increasingly sophisticated in the realm of predictive modeling. Most of these efforts occurred with respect to high frequency monthly data, especially univariate autoregressive moving average models (Box and Jenkins, 1976). While often regarded as competitors, time series models are frequently utilized as complements to econometric equation sets and can also be imbedded within a variety of forecasting systems (Clemen, 1989; Fullerton, 1989a; Zellner, 1994; West, 1996).

Latin American macroeconomic forecasting models began to appear in the 1960s (Beltrán del Río, 1991). Similar to the first models for the Netherlands and the United States, the early Latin American models utilized systems of simultaneous equations designed around national income and product account (NIPA) data. Unlike most industrialized economies, however, NIPA data in Latin America during this period tended to be published only at an annual frequency. This constraint precluded the development of Latin American quarterly forecasting models in a manner analogous to what occurred in many industrialized economies.

Although quarterly forecasting models have not been widely disseminated in Latin America, large-scale forecasting models built using annual NIPA data abound. Representative examples include the CIEMEX-WEFA model for Mexico (Beltrán del Río, 1991), the CIEPLAN model for Chile (Vial, 1988), the Metroeconómica model for Venezuela (Palma and Fontiveros, 1988), and the WEFA models for Colombia and Ecuador (Fullerton, 1993a, 1993b). Among the most distinguishing characteristics shared by these models are continuous maintenance and enhancement over sustained periods of time. All of the aforementioned studies provide detailed references to the history of macroeconometric modeling in the region. Econometric forecasting analysis using annual data in Latin America has a fairly distinguished history and track record that is well-documented.

Given the volatile behaviors of the majority of the economies in Latin America in the 1980s, the absence of quarterly forecasting tools hampered business planning efforts. Forecasting conferences sponsored by commercial entities such as Wharton Econometrics during the late 1980s utilized simulation output from annual structural models for Latin American countries of interest. Client questions at these meetings were generally directed toward the first year of the forecast period, largely ignoring outer period extrapolation results (for example, see Fullerton, 1991).

This is not to imply that the traditional macroeconometric Latin American models are regarded as useless. Most analyses of international indebtedness typically rely on annual data in order to examine the consequences of changes in regional balance of payment factors. Not surprisingly, significant effort was put forth in recent years to enhance the current account-capital account linkages and simulation performances in Latin American macroeconomic models (Fullerton, 1993a). The relative lack of forecasting models estimated with higher frequency data, nevertheless, continues to pose an obstacle to corporate, public sector, and multilateral agency planners and economists.

Although quarterly national income and product account data are still not widely available to researchers in Latin America, monthly time series for many economic variables do

exist. Examples of the latter include inflation indices, money supply measures, currency exchange rates, commodity export prices, and international reserves. A logical step, therefore, is to investigate the econometric properties and predictability of the series presently available at the higher frequency. The centerpiece chapters of this dissertation examine three empirical forecasting questions using monthly data sets from Colombia, Ecuador, and Venezuela. Distinct estimation techniques are employed in each chapter and simulation accuracy is summarized for all of the models presented therein.

Chapter 2 utilizes a transfer function autoregressive integrated moving average (transfer ARIMA) modeling framework to analyze movements in consumer prices in Colombia. Forecasting experiments are conducted with the resulting model to shed light on potential impacts associated with an anti-inflationary program enacted by the central bank. Results indicate that this class of time series modeling can provide useful insights with respect to macroeconomic trends in Latin American countries. A revised version of this chapter was published in the **Journal of Policy Modeling** (Fullerton, 1993c).

Chapter 3 also examines the question of forecasting short-term price movements. Consumer prices in Ecuador are modeled using an econometric framework that incorporates domestic macroeconomic factors and international input costs.

Parameter estimation is accomplished with a nonlinear procedure that provides sufficient flexibility to handle even mixed error structures. Simulation exercises are also utilized to examine possible consequences associated with a price stabilization program implemented by the central bank. An abridged version of this study was published in **Proceedings of the American Statistical Association**, Business and Economic Statistics Section (Fullerton, 1995a).

Secondary market trades involving sovereign debt certificates became widespread following the outbreak of the international debt crisis in 1982. Chapter 4 employs a generalized least squares modeling strategy to study the predictability of short-run movements in secondary market debt prices in Colombia, Ecuador, and Venezuela. As discussed below, forecast period lengths and information inputs are selected to reflect considerations facing financial market participants. A revised version of this chapter appeared in **Applied Economics** (Fullerton, 1993d). Additional research extending the initial results on this topic was presented at the 65th annual Southern Economic Association conference (Fullerton, 1995b).

CHAPTER 2
INFLATIONARY TRENDS IN COLOMBIA

2.1 Introduction

Inflation has long been one of the most serious economic problems facing policymakers in Latin America. Although Colombia has traditionally enjoyed lower rates of inflation than neighboring South American countries, in 1990, a presidential election year, consumer prices rose in excess of 32 percent. In response, Colombian monetary authorities introduced a series of policy innovations designed to lower the inflation rate. Measures adopted include a progressive opening of the economy to greater volumes of international trade, fiscal austerity, tighter credit controls, and a slower rate of currency devaluation (for details, see Fullerton, 1991).

This chapter examines some of the potential results associated with the principal tools of the policy adjustment effort. Time series characteristics of the consumer price index (CPI), the money supply (M1, defined as currency in circulation plus demand deposits), and the peso/dollar exchange rate (REX) are investigated. To measure the short-run relationships among the CPI, M1, and REX, transfer

function autoregressive-moving average (ARIMA) analysis is applied (see Box and Jenkins, 1976, ch. 11).

Selection of the nonlinear model estimation methodology was motivated by two factors. First was the usefulness of transfer function ARIMA analysis for short-term forecasting applications. Second was interest expressed in a previous study which utilized this technique to analyze price dynamics in the United States (Fullerton, Hirth, and Smith, 1991). Specifically, economists within the Research Department of the Central Bank in Bogotá wished to see whether the same approach would prove useful with respect to the Colombian economy.

Subsequent sections of the paper present a brief review of the literature, methodology, and empirical results. Policy simulation exercises designed to reflect exchange rate and monetary policies in Colombia follow. A summary and conclusion form the final section of the chapter.

2.2 Previous Research

In one of the earliest time series studies developed for an economy in Latin America, Cabrera and Montes (1978) utilize univariate ARIMA techniques to model the CPI in Colombia. Logarithmic transformation, regular and seasonal differencing of the monthly CPI series are used to induce stationarity. An equation containing an autoregressive term at lag 1 and a seasonal moving average term at lag 12 yields statistically significant parameter estimates. While simple in structure,

the model exhibits good statistical traits and is found to simulate historical movements of the CPI successfully. Empirical evidence is provided that Colombian inflation, although high relative to many industrial economies, is stable enough to be modeled and predicted with a fair degree of accuracy.

Montes and Candelo (1982) propose a simultaneous system of equations for money, prices, international reserves, and the exchange rate. Full information maximum likelihood estimation is used to calculate model parameters which reflect the hypothesized coefficient restrictions. Although quarterly data are used, the lag structure of the model is fairly simple. Domestic monetary conditions and the rate of devaluation are both found to positively affect consumer prices in a statistically significant manner. The magnitudes of the exchange rate coefficients exceed those of the monetary variables in each of the different sample periods.

Leiderman (1984) utilizes vector autoregressions to analyze inflation in Colombia and Mexico. Changes in the rates of growth in the economy and the money supply are included in each model. In the case of Colombia, the results indicate that variations in the rate of change of M1 systematically affect the CPI, but not the converse. From a policy perspective, this implies that monetary authorities do not engage in "accommodative" measures in response to production and inflationary shocks. This result may stem from

the usage of monetary policy to achieve goals other than price stability. These include economic growth and export diversification. From an econometric standpoint, this result is also important because it implies that unidirectional Granger causality exists between M1 and the CPI in Colombia.

A number of recent studies have examined inflationary dynamics in the United States. Koch, Rosensweig, and Whitt (1988) investigate the relationship between the exchange rate and consumer prices. Cross correlation functions are used to suggest the number of lags to be included in the regression equations. Granger causality tests imply a unidirectional channel of influence from the exchange rate to prices. The inflationary impacts associated with a change in the international value of the dollar are found to extend more than 12 months.

Fullerton, Hirth, and Smith (1991) consider the effects of exchange rate and other financial and commodity price variable movements on the CPI in the United States. Transfer function ARIMA analysis indicates that inflationary impacts resulting from variations in the exchange rate generally take more than a year. Credit conditions, as proxied by interest rate spreads, are found to influence consumer prices relatively quickly. The slow speed of adjustment from the exchange rate compared to domestic financial conditions may reflect incomplete pass-through effects which characterize large industrial economies.

This is in contrast to what might be expected for a smaller economy such as Colombia's, where pass-through effects, statistically significant relationships between international currency values and inflation, are often strong and relatively quick (see Leith, 1991). Empirical evidence reported elsewhere (Edwards, 1985) indicates that movements in the rate of devaluation are helpful in modeling nominal interest rates in Colombia. Unfortunately, the latter study does not directly test the relationship between prices and the peso/dollar exchange rate.

2.3 Methodology

The methodology utilized in this paper is similar to the multiple ARIMA approach applied to the United States by Fullerton, Hirth, and Smith (1991). This technique does not apply any a priori modeling restrictions on the equations estimated. It is a useful procedure for investigating high frequency time series data because it can accommodate different lag structures in a flexible and efficient manner. Equations developed using this approach are also easy to simulate and can help analyze policy proposals.

Univariate ARIMA equations are estimated for the stationary components of the CPI, M1, and REX series. The results are then used to specify and estimate an ARMA transfer function. A weakly stationary series is defined as one whose mean and variance do not change over time. Stationarity in

the means of the series is attained through regular and seasonal differencing. Logarithmic transformations are used to induce homoscedasticity (see Pankratz, 1983).

The general form of a univariate ARIMA model estimated for the CPI can be written as follows:

$$(2.1) \qquad P_t = [Q(B)Q^s(B)U_t] \ / \ [H(B)H^s(B)] \ ,$$

where P_t is a stationary series derived from the original CPI series, B is a backshift or lag operator, Q(B) is a moving average polynomial of order q, $Q^s(B)$ is a seasonal moving average polynomial of order q^s, U_t is the disturbance term, H(B) is an autoregressive polynomial of order p, and $H^s(B)$ is a seasonal autoregressive polynomial of order p^s. The ARMA model for the CPI is also used in the estimation of the transfer function equations.

To examine the effects of other variables on the CPI, transfer function ARIMA models are estimated. These models are used to determine if the input series are incrementally useful in explaining the variation of the CPI beyond the information obtained within the price index itself (see Box and Jenkins, 1976, ch. 11). Prior to estimating a transfer function equation, cross correlation functions (CCF) are used to indicate which lags of an input series may contribute incremental information to the univariate ARMA model already estimated for the CPI. Residuals from the three univariate

equations are used to calculate CCFs between the CPI and the other variables (see Chatfield, 1984, p. 173).

Statistical, or Granger, causality is assumed to be unidirectional in transfer ARIMA models. If this assumption is reasonable, movements in REX and M1 will chronologically precede statistically significant changes in CPI. The converse will not hold if causality is unidirectional. To examine the possibility that feedback or endogeneity exists between the CPI and the other series, ordinary least squares regression is used to construct Granger causality F-tests.

The general form of the transfer function can be written in the following manner:

$$P_t = [W(B)R_t + G(B)M_t + Q(B)Q^s(B)U_t] \;/\; [H(B)H^s(B)] \;, \tag{2.2}$$

where the univariate model presented in Equation 2.1 is augmented by incorporating general order polynomials, W(B) and G(B), for the respective input variables. R_t and M_t represent stationary input series derived from the exchange rate and the money supply data discussed above. Because the analysis is conducted within a dynamic framework, coefficient restrictions are not hypothesized, but the sums of the coefficients associated with each individual input series are expected to be positive.

2.4 Estimation Results

Data used in this chapter are from the central bank in Bogotá. Monthly observations for all three series are published in **Revista del Banco de la República** (for example, see Cabrera and Montes, 1978). The sample period, January 1967 through December 1990, corresponds to the crawling peg era of exchange rate determination in Colombia.

Similar to Cabrera and Montes (1978), a logarithmic transformation of the CPI is taken prior to regular and seasonal differencing to obtain stationarity. The same steps are taken with respect to REX and M1 prior to modeling. Results of the stationarity tests for all three series appear in Table 2.1. The unit root tests are performed with both constant and trend terms.

Autocorrelation and partial autocorrelation functions suggested the forms of the univariate ARIMA equations reported in Table 2.2. Despite the presence of 11 years of additional data, the results confirm the AR(1), SMA(12) specification employed by Cabrera and Montes (1978, p. 1137) to model the CPI. Parameter estimates reported in Model 2.3 carry the same signs and are similar in magnitude to those estimated in the previous study (0.450 versus 0.645, and -0.924 versus -0.858). Equation 2.3 is incorporated in the estimation of the transfer function equations.

Table 2.1: Unit Root Tests for Stationarity

Series	Aug Dickey-Fuller t-stat	MacKinnon crit value
P	- 9.081 (with const, trend, 1 lag)	-4.001 (1% lvl)
R	- 5.252 (with const, trend, 1 lag)	
M	-13.195 (with const, trend, 1 lag)	

Table 2.2: Univariate ARIMA Models

Model		Parameters				
2.3	CPI					
P_t	=	0.001 (10.186)	+	$0.450 * P_{t-1}$ (11.397)	-	$0.924 * U_{t-12}$ (15.900)
	Q(38) = 52.222					
2.4	REX					
R_t	=	0.001 (8.827)	+	$0.795 * R_{t-1}$ (27.671)	-	$0.784 * U_{t-12}$ (13.148)
	Q(38) = 31.893					
2.5	M1					
M_t	=	0.001 (7.715)	-	$0.229 * U_{t-1}$ (4.465)	-	$0.634 * U_{t-12}$ (10.558)
	Q(38) = 59.339					

The sample period is January 1967 - December 1990.
Numbers in parentheses are computed t-statistics.
Ljung-Box Q-statistics calculated for 38 lags are reported.

Ordinary least squares F-tests are used to determine if unidirectional Granger causality exists between consumer prices and the two input series. Results for the F-tests, calculated for 12 and 18 lags, are reported in Table 2.3. The tests constructed to examine the relationship between the CPI and M1 utilize seven years of additional data, but support the conclusions reported by Leiderman (1984). Because monetary policy in Colombia appears to be conducted independently of inflationary shocks, the transfer function methodology can be used to measure the effect of the money supply on inflation.

Similar to results reported for the United States (Koch, Rosensweig, and Whitt, 1988), the causality tests for the CPI and REX series indicate that changes in the inflation rate do not precede systematic variations in the exchange rate. From an historical perspective, the result is not surprising. There have been several episodes during the crawling peg era in Colombia when authorities have permitted the exchange rate to become overvalued by failing to devalue the local currency quickly enough to account for inflationary differentials with major trading partners. Typically, this has tended to take place following "coffee bonanzas" when Colombian international reserves are high due to strongly positive merchandise trade surpluses (Kamas, 1986; Ocampo, 1983).

Table 2.3: Granger Causality Tests

Causality Direction	Number of Lags	Computed F-stat
CPI => REX	12	0.834
CPI => REX	18	0.799
CPI => M1	12	0.009
CPI => M1	18	0.278

Degrees of freedom for the regressions with 12 lags:
12 for the numerator and 263 for the denominator.

Degrees of freedom for the regressions with 18 lags:
18 for the numerator and 251 for the denominator.

There have also been periods when local price changes have moved in concert with those of Colombia's trading partners, rendering unnecessary any modification in the crawling peg. As a result, the rate of devaluation has not always been adjusted proportionately to variations in the domestic rate of inflation. From an economic policy perspective, the results in Table 2.3 indicate that Colombian monetary authorities take into account goals and variables other than domestic inflation when determining rate of devaluation embodied in the crawling peg for the peso. Econometrically, this implies that transfer function ARIMA analysis can be used to model the influence of the international value of the peso on domestic prices.

Similar to the CPI, stationarity in the REX and M1 series is attained after logarithmic transformation, and seasonal and regular differencing. Unit root tests for both variables are reported in Table 2.1. As noted above, univariate equations for the exchange rate and money supply series appear in Table 2.2. These equations also exhibit good statistical traits such as high computed t-statistics and relativley low Q-statistics. Residuals from the three univariate models were used to estimate CCFs containing 18 lags. Both CCFs indicated that the principal effects resulting from a change in either input variable are incorporated in the CPI within a relatively short period.

Transfer function equations are reported in Table 2.4. Models 2.6 and 2.7 include only one independent variable, REX and M1, respectively. Model 2.8 includes both input series. The exchange rate is included with lags of 2 and 10 months. The money supply is included with a 9-month lag. Autoregressive terms at lag 1 and seasonal moving average terms at lag 12 are included in all three equations. Similar to Montes and Candelo (1982), the exchange rate input coefficients are larger than that of M1.

Inclusion of the input series improves the Q-statistic estimated from the residuals associated with each equation. Virtually all of the improvement in the white noise test results from the introduction of the lagged stationary exchange rate data. Coefficients estimated for these series are statistically significant in Model 2.6 and Model 2.8. The lagged stationary component of the money supply exhibits the hypothesized sign, but is not significant at the 5-percent level.

Because money is a useful predictor of inflation in Colombian macroeconometric models using annual data (Fullerton, 1993a), the results encountered in this chapter are unexpected and further research is warranted. Another possibility is that M1 may not be the correct money stock measure with respect to Colombian price dynamics. Studies completed for other economies indicate that broader liquidity aggregates such as M2 may be useful (Hallman, Porter, and

Table 2.4: ARIMA Transfer Functions

Model				Parameters		
2.6	CPI					
P_t	=	0.018 (8.423)	+	$0.459*P_{t-1}$ (11.623)	−	$0.890*U_{t-12}$ (15.190)
			+	$0.201*R_{t-2}$ (2.215)	+	$0.076*R_{t-10}$ (4.088)
	Q(38) = 39.826					
2.7	CPI					
P_t	=	0.018 (9.476)	+	$0.447*P_{t-1}$ (11.334)	−	$0.929*U_{t-12}$ (15.974)
			+	$0.030*M_{t-9}$ (1.638)		
	Q(38) = 51.777					
2.8	CPI					
P_t	=	0.018 (8.113)	+	$0.457*P_{t-1}$ (11.570)	−	$0.895*U_{t-12}$ (15.235)
			+	$0.216*R_{t-2}$ (2.384)	+	$0.077*R_{t-10}$ (4.133)
			+	$0.034*M_{t-9}$ (1.839)		
	Q(38) = 39.389					

The sample period is January 1967 - December 1990.
Numbers in parentheses are computed t-statistics.
Ljung-Box Q-statistics calculated for 38 lags are reported.

Small, 1991, and Ikhide and Fullerton, 1995). Unfortunately, money supply estimates other than M1 currently do not exist for Colombia. This problem is fairly widespread in South America and has long posed difficulties in the analysis of monetary economics in the region (see Fullerton and Kapur, 1991).

2.5 Policy Simulation Results

The Gaviria administration announced in December 1990 that it would attempt to lower the inflation rate to 22 percent in only twelve months (for discussion, see Fullerton, 1991). To attain this goal, two principal tools were to be employed. After an extended period of aggressive devaluation, the nominal rate of devaluation for the peso/dollar exchange rate was to be reduced. Policymakers also announced that growth in the money supply would be limited to 22 percent.

To examine the potential effects of these policy innovations on the CPI, simulations are created using Equation 2.8. In the first exercise, the 12-month growth rate for M1 is assumed to be immediately limited to 22 percent for an initial 12-month period, and then lowered to 19 percent the following year. Similarly, the 12-month crawling peg rate of devaluation is assumed to be held at 22 percent throughout the first year, and later be revised downward to 19 percent during the following year. The 19 percent rates of change are chosen to reflect longer-term policy goals discussed by the

government, including eventual attainment of a 15 percent annual rate of change for consumer prices (Fullerton, 1991).

Simulating Model 2.8 under these policy assumptions yields several interesting results that are reproduced in Table 2.5. During the first six months, the inflation rate oscillates near 29 percent. Subsequently, the 12-month rate of change in the CPI declines sharply to 24 percent by year-end. During the next 12 months, disinflation subsides as the severity of the cutbacks in the rates of change of both input variables is moderated. Year-end inflation declines to 22 percent under this scenario. As will be illustrated below, not all of the 10-point improvement can be attributed to the government policy package.

Not surprisingly, Colombian monetary authorities did not introduce the exchange rate and credit policy changes in the abrupt manner depicted above. Accordingly, Equation 2.8 is also simulated under an alternative set of assumptions whereby intermediate policy steps are implemented more gradually. Additionally, actual exchange rate and money supply data for the first six months of 1991 are employed. These data reflect slower attainment of the new policy goals espoused by the Finance Ministry and the Central Bank. Subsequent movements in the 12-month rates of change for the exchange rate and the money supply are assumed to steadily decline to 19 percent by December 1992 for both variables.

Table 2.5: Immediate Implementation Policy Simulation Results

Month	PCHYA(CPI)	PCHYA(REX)	PCHYA(M1)
1	32.1	22.0	22.0
2	30.7	22.0	22.0
3	28.9	22.0	22.0
4	29.1	22.0	22.0
5	29.6	22.0	22.0
6	29.2	22.0	22.0
7	28.9	22.0	22.0
8	27.9	22.0	22.0
9	26.8	22.0	22.0
10	26.2	22.0	22.0
11	25.2	22.0	22.0
12	24.1	22.0	22.0
13	23.5	19.0	19.0
14	23.3	19.0	19.0
15	22.5	19.0	19.0
16	22.5	19.0	19.0
17	22.4	19.0	19.0
18	22.4	19.0	19.0
19	22.4	19.0	19.0
20	22.4	19.0	19.0
21	22.4	19.0	19.0
22	22.3	19.0	19.0
23	22.1	19.0	19.0
24	22.1	19.0	19.0

Results of the second simulation exercise are reported in Table 2.6. The more rapid rate of depreciation allows the 12-month inflation rates to remain above 30 percent throughout the first semester of the test period. Steady declines in the rates of change for both REX and M1 force inflation to decline noticeably during the next six months, eventually reaching 25 percent. Year-end inflation slows to 22 percent during the subsequent 12-months of the simulation period, when growth rates for the input variables gradually decline to 19 percent.

It is useful to note that the second set of medium-range simulation results reported in Table 2.6 do not vary significantly from those obtained in the first exercise. Despite imperfect implementation efforts, these results indicate that the government can still attain its stated policy goals. Because a 24-month period is still needed to lower the rate of change in the CPI by 10 percentage points, the government policy claims are again shown to be slightly optimistic. Furthermore, as shown in the final simulation exercise presented in Table 2.7, much of the improvement in the inflation rate cannot be attributed to policy design alone.

Of course, policy indecision can also result in no progress being made toward achieving either intermediate target. To examine the potential consequences associated with such an eventuality, model simulations were also tested in

Table 2.6: Gradual Implementation Policy Simulation Results

Month	PCHYA(CPI)	PCHYA(REX)	PCHYA(M1)
1	32.1	29.9	28.2
2	30.7	28.9	22.3
3	30.7	27.8	25.0
4	30.6	26.8	22.6
5	30.8	25.8	30.3
6	30.3	23.6	26.2
7	29.8	23.0	26.0
8	28.3	22.5	25.5
9	27.0	22.0	25.0
10	26.5	21.5	24.5
11	25.8	21.0	24.0
12	24.6	20.5	23.5
13	23.8	20.0	23.0
14	23.6	19.9	22.5
15	23.2	19.8	22.0
16	22.9	19.7	21.5
17	22.8	19.6	21.0
18	22.7	19.5	20.5
19	22.7	19.4	20.0
20	22.6	19.3	19.8
21	22.5	19.2	19.6
22	22.4	19.1	19.4
23	22.3	19.0	19.2
24	22.3	18.9	19.0

Table 2.7: No Implementation Policy Simulation Results

Month	PCHYA(CPI)	PCHYA(REX)	PCHYA(M1)
1	32.2	30.0	30.0
2	31.9	30.0	30.0
3	31.6	30.0	30.0
4	31.2	30.0	30.0
5	30.9	30.0	30.0
6	30.6	30.0	30.0
7	30.3	30.0	30.0
8	29.9	30.0	30.0
9	29.6	30.0	30.0
10	29.4	30.0	30.0
11	29.2	30.0	30.0
12	28.8	30.0	30.0
13	28.5	30.0	30.0
14	28.3	30.0	30.0
15	28.0	30.0	30.0
16	27.7	30.0	30.0
17	27.4	30.0	30.0
18	27.1	30.0	30.0
19	26.8	30.0	30.0
20	26.6	30.0	30.0
21	26.4	30.0	30.0
22	26.2	30.0	30.0
23	26.3	30.0	30.0
24	26.2	30.0	30.0

which the growth rates of the input series were held constant at 30 percent per year. In the absence of any change in the conduct of monetary management and depreciation rate determination, the annual rate of inflation stabilizes at 26 percent by the end of the 24-month simulation period. That rate is well above the announced government target range.

More importantly, the 6-point improvement which results in a simulation exercise in which no progress is made with respect to the intermediate policy targets. This result indicates that only 40 percent of policy attainment embodied in Tables 2.5 and 2.6 is by government design. The remaining six-tenths of the 10-point reduction in the annual rate of change in consumer prices would, on the basis of the above modeling and simulation framework, have resulted anyway.

2.6 Conclusion

In response to growing inflationary pressures, economic policymakers in Colombia announced that the inflation rate would be slashed by 10 percentage points to 22 percent over a 12-month period. Two principal tools were selected to foster disinflation. The nominal rate of devaluation for the peso/dollar exchange rate was cut and the rate of growth of the money stock was reduced.

This chapter examines the empirical relationship between those variables and the consumer price index. Econometric results are similar to those reported in previous studies for

Colombia and the United States. Transfer ARIMA functions are estimated and simulated to determine the potential impacts of the new policies. These exercises indicate that substantial progress in the anti-inflationary program may be attained following the implementation of said policy efforts, although not as quickly as stated by government officials. More importantly, over half of the 10-point gain results even if the rates of nominal currency devaluation and money supply expansion are held constant.

Because of structural economic and administrative policy changes taking place in Colombia, additional research will eventually be necessary. Future studies may find it useful to consider the effects of other variables such as wage rates, industrial capacity utilization, and commodity prices on the CPI. Given the insignificant, at the 5-percent level, coefficient associated with M1, model estimation utilizing alternative series designed to reflect monetary conditions may also prove helpful. Introduction of new variables such as wage rates may necessitate usage of an estimation technique different from the transfer function methodology described above. This is due to the possibility that feedback effects, or simultaneity, may exist between the CPI and other potential input series.

At present, the Colombian economy is being opened to international trade and a free-market exchange rate system is slated to be implemented. These policy innovations could

potentially render the above parameter estimates obsolete. ARIMA intervention analysis (Box and Tiao, 1975) may prove beneficial in subsequent empirical research designed to examine this possibility. It is interesting to note, however, that the similarities between the empirical results reported in this paper and those analyzed in earlier studies indicate that agent responses have generally been relatively inelastic with respect to changing monetary and exchange rate policies in Colombia.

CHAPTER 3
SHORT-TERM PRICE MOVEMENTS IN ECUADOR

3.1 Introduction

Similar to other Latin American economies, Ecuador has faced persistently high rates of inflation in recent years. Although inflation was substantially lower in 1993 and 1994, excessive money supply growth in early 1995 clouded prospects for additional short-term improvements. Prior to the first-quarter 1995 border skirmish with Perú, the government had signed a stand-by loan agreement with the International Monetary Fund that established a goal of reducing the inflation rate to 15 percent over a 19-month time frame (Banco del Pacífico, 1994a). Not withstanding government assurances that inflation would decelerate to its target rate by year-end 1995, very little econometric analysis using short-term forecasting methods appears to have been relied upon in developing the new policy targets.

In its attempt to slow price movements, the Durán Ballen-Dahik Garzozi administration introduced a variety of new policy measures. They include import liberalization, fiscal austerity, and a slower rate of currency depreciation. By reducing price pressures, the government hopes to improve economic welfare by enabling the Ecuadorian economy to operate

more efficiently. This argument is very similar to those aired in advanced economies such as the United States (Motley, 1993) and analyzed in other developing nations (Zind, 1993). What is unique, however, is the magnitude of the disinflationary goals set by the Ecuadorian policymakers. As a result, short-run price stabilization has become the center piece of government policy efforts in Ecuador.

This chapter examines potential results associated with the two principal adjustment tools, money supply growth and exchange rate movements. Despite ongoing difficulties with inflationary uncertainty and the ambitious nature of current policy goals, careful econometric analysis of short-run price movements in Ecuador has not previously been conducted. To bridge this gap, a modeling framework is proposed, tested, and used to develop policy simulation exercises for monthly Ecuadorian price data.

In contrast to the time series methodology utilized for Colombia, an econometric approach is followed in the analysis conducted for Ecuadorian price movements. Selection of this alternative approach was motivated by two factors. First was a discussion on quantitative analysis of developing country inflation held at the 32nd International Atlantic Economic Conference. Second was interest expressed by economists at the Research Department of the Central Bank in Quito with respect to attempting to develop a short-run inflationary model similar to the long-run monetary-import cost approach

incorporated in Fullerton (1993b). Subsequent sections of this chapter offer a review of the literature, theoretical model, and empirical results. Suggestions for future research are summarized in the conclusion.

3.2 Literature Review

The seminal research on inflationary dynamics in developing countries was conducted on Chilean data by Harberger (1963). That early paper interestingly points out that analyzing nominal data in level form could result in spurious correlations in equations estimated for highly inflationary economies. To circumvent this problem, percentage rates of change are utilized in a linear regression framework based on the quantity theory of money. What became known as the "Harberger" framework incorporates real income, current and lagged values of the money supply, and the opportunity cost of holding cash balances.

The success of this initial effort conducted on Chilean data spurred a series of replicated studies for other developing countries. Vogel (1974) estimates an inflation equation for several Latin American economies, including Ecuador, using annual data. Results confirm the overall usefulness of the Harberger model. Unlike the study at hand, Vogel utilizes a sample period during which inflation averaged less than 4 percent per year in Ecuador and the exchange rate was fixed.

Following numerous applied econometric studies utilizing this approach, it became apparent that its reliance on domestic variables alone often provided unsatisfactory results. Bomberger and Makinen (1979) provide a thorough examination of the Harberger model using quarterly data for Korea, Taiwan, and Vietnam. Extensive testing is conducted using quarterly data in order to establish whether a suitable characterization of inflation is provided. Encouragingly, the parameter estimates do not appear sensitive to the time period selected. However, the elasticities with respect to money and real income are not always unitary as hypothesized. Also, the coefficient signs for the cost of holding money variables are sometimes negative.

Hanson (1985) extends the Harberger framework in a systematic fashion to incorporate an important missing component, import costs. An implicit cost function is utilized to derive an aggregate supply curve which includes local prices of imported inputs. When the underlying production function is homogeneous of degree one, inflation becomes a weighted sum of money supply changes and import prices. This is important for studies using higher frequency data if the problem of measurement bias engendered by interpolated values of real output, generally published on either a quarterly or annual basis in developing countries, is to be avoided (see Bomberger and Makinen, 1979). The model also implies the elasticity of inflation with respect to money

growth is less than one. Empirical results in the Hanson article strongly support the inclusion of import prices or the rate of devaluation in models of inflation.

Subsequent research has provided additional evidence in favor of the augmented Harberger-Hanson approach wherein the effect of import prices on inflation is considered. Koch, Rosensweig, and Witt (1988) and Fullerton, Hirth, and Smith (1991) both report positive linkages between the trade-weighted exchange value of the dollar and consumer prices in the United States. These empirical studies indicate a unidirectional channel of influence from the exchange rate to domestic prices exists in the United States economy. As will be discussed below, causality direction has important implications for both model form and estimation technique.

Developing country studies have also confirmed the usefulness of an augmented modeling treatment of inflationary dynamics. Sheehey (1976) reports some of the early econometric work along these lines. Sheehey (1980) reaches additional conclusions on the basis of empirical tests that indicate that accurate assessment of austerity policy efforts will likely require explanatory variables representing cost push factors. More recently, Brajer (1992) provides evidence that the latter category of models may offer better specifications than those which rely solely on domestic economic factors. Conclusions in that article are reached on the basis of F-tests for different regressor sets. Similarly,

Fullerton (1993b) successfully imbeds a variant of this approach in a large-scale macroeconometric forecasting model for Ecuador using annual data.

There have been very few dynamic models estimated on the basis of monthly data for developing economies. Given that most business decisions in highly inflationary countries are reached within a short-range context, this is an area which needs to be addressed. As detailed in Chapter 2, Fullerton (1993c) empirically examines Colombian anti-inflationary efforts utilizing monthly data with an ARIMA transfer function. The estimated model is found to generate realistic simulation scenarios for policy analysis. The results also support the hypothesis of inflation rate inelasticity with respect to monetary growth. As in the Chilean equation reported by Hanson (1985), and the Argentine model presented in Sheehey (1976), exchange rate price effects are found to outweigh the monetary coefficient. The latter is somewhat surprising given that imported goods and services comprise less than 20 percent of Colombian gross domestic product.

3.3 Theoretical Model

Harberger's (1963) model is based on the traditional quantity theory of money equation:

$$MV = PQ, \tag{3.1}$$

where M represents some measure of the money stock, V is the velocity of circulation, P is the price level, and Q is real output. Velocity is not assumed to be constant. Instead, it is hypothesized to be a predictable function of other macroeconomic variables such as the cost of holding cash balances. Given the typical variability of velocity in many Latin American economies, this aspect of the theoretical model is potentially important (see Clavijo, 1987).

To utilize percentage changes, the variables can be transformed by natural logarithms and first differenced. Introduction of a time subscript, and rearrangement of the terms, yields the basic Harberger equation:

$$(3.2) \qquad DP_t = DM_t - DQ_t + D(DP_{t-1}),$$

where the last term results from substituting for velocity and D represents a difference or backshift lag operator. Usage of the lagged change in the inflation rate to proxy for the implicit cost of holding money is motivated by the fact that developing countries such as Ecuador have frequently imposed government regulations on interest rates. The latter have occasionally caused savings and loan rates to become negative in real terms. Unadjusted interest rates from these periods in Ecuadorian economic history do not, therefore, provide accurate estimates for the cost of holding idle cash balances.

Equation 3.2 implies that inflation will vary positively with the money supply and inversely with respect to real output. A statistically significant intercept term will enter the estimated equation if there is a trend in the velocity of circulation. If only contemporaneous lags of M and Q enter in the equation, the parameters for both variables are hypothesized to be unitary. This can be tested empirically with the following specification:

$$(3.3) \qquad DP_t = a_0 + a_1DM_t - a_2DQ_t + a_3D(DP_{t-1}) + u_3,$$

where a_1 and a_3 are hypothesized to be positive, and the absolute values of a_1 and a_2 should both be statistically indistinguishable from one. The last argument in the expression represents the disturbance term.

Hanson (1985) proposes an implicit cost function dual of an aggregate production function which is homogeneous of degree one. Derived output supply functions from this framework will be homogeneous of degree zero in input and output prices. Equation 3.4 expresses this relationship using logarithmic first differences:

$$(3.4) \qquad DQ_t = b_0 + b_1DP_t - b_2DPI_t + u_4,$$

where PI represents imported input prices. When the relative prices of imported inputs increase, output is assumed to

decline. The standard homogeneity assumptions for production and derived supply relations imply that $b_1 - b_2 = 0$.

Equation 3.4 can be substituted into Equation 3.3 to eliminate the output term from the expression to be estimated. As noted in the literature review, this step is useful for avoiding interpolation bias in empirical studies of monthly inflation for countries such as Ecuador where GDP is published at quarterly and/or annual frequencies. The resulting equation can be written as follows:

$$(3.5) \qquad (1 + a_2b_1)DP_t = a_0 - a_2b_0 + a_1DM_t + a_2b_2DPI_t + a_3D(DP_{t-1}) + u_5.$$

Equation 3.5 can be further simplified prior to estimation. Dividing through by the left-hand side constant term and rearranging terms such that the price series remains as the dependent variable yields the following relation:

$$(3.6) \qquad DP_t = c_0 + c_1DM_t + c_2DPI_t + c_3D(DP_{t-1}) + u_6,$$

which also has testable properties. Importantly, the coefficient on the monetary variable, c_1, is now hypothesized to be significantly less than one. Also important, with the possible exception of the intercept, all of the regression parameters in Equation 6 are expected to be positive.

Several other properties of this model are worth noting. In particular, the theoretical coefficient restrictions described earlier have interesting implications. Namely, a_1 and a_2 are hypothesized as equal to one, and b_1 and b_2 are equal in absolute value in the version of the model developed thus far. Substitution into Equation 3.5 implies $c_1 + c_2 = 1$, which can also be tested.

As indicated in the literature review, Equation 3.6 has provided a useful framework for analyzing quarterly and annual inflation rates. But because the lag structure in this model is fairly short, it may require additional modification prior to estimation. This possibility does not reflect any deficiencies in the theoretical model as such, but arises due to the fact that short-term models rely upon monthly data. As a result, if the inflationary impact of a change in the money supply is felt over the course of one calendar year, the implied lag structure for a model estimated with data published at a monthly frequency would potentially range up to 12-months in length. Equation 3.7 takes into account this empirical issue which has confronted and confounded researchers for many years (see Laidler, 1993):

$$(3.7) \qquad DP_t = c_0 + c_1 DM_{t-i} + c_2 DPI_{t-j} + c_3 D(DP_{t-1-k}) + u_7,$$

where lag subscripts i, j, k = 0, ..., n, respectively.

The above model provides an attractive starting point for examining inflationary trends in an economy. It is not, however, without potential problems for analyzing price movements in a relatively high inflation country such as Ecuador. A principal concern arises from the fact that Equation 3.7 treats all of the regressors as exogenous or predetermined. In doing so, it does not allow for the possibility of statistical feedback or endogeneity between the left-hand and right-hand side variables.

If a central bank yields to political pressures and engages in accommodative monetary policy in the face of inflation shocks, this assumption would be violated. As noted in Chapter 2, research conducted using higher frequency data for Colombia indicates that the causality paths in that economy are unidirectional as implied by Equation 3.7 (see Fullerton, 1993c, and Leiderman, 1984). While short-term forecasting models for Ecuadorian inflation have not been previously developed, domestic prices, monetary aggregates, and import prices are modeled simultaneously in the macroeconometric model estimated using annual data by Fullerton (1993b). It would not be surprising if the feedback relations encountered in that paper also emerge in the monthly time series utilized below. As noted elsewhere, monetary authorities in Ecuador have occasionally been forced to yield to political pressures (Garlow, 1993). Granger causality

tests will be used to test the severity of this potential problem.

A second possible concern arises from utilizing first differenced, log-transformed time series data in the equation to be estimated. If the resulting series are stationary, the equation can be estimated without risk of obtaining spurious correlations in the results. As shown in many studies of hyperinflationary economies, however, higher order differencing may be required to induce stationarity during periods in which prices increase rapidly (Engsted, 1993). Because Ecuador has not undergone any hyperinflationary episodes, first differencing should remove nonstationary trends from the variables in question but this assumption must be tested. The latter tests are accomplished below via a battery of unit root tests, not all of which are reported.

A third concern arises from the fact that monthly import price deflators do not exist for Ecuador. To circumvent this problem and also avoid interpolation bias, a trade-weighted exchange rate index is used as a proxy for imported input prices. The index utilized was developed econometrically and takes into account export and import volume changes with Ecuador's major trading partners. It also offers a single monthly index for periods when the government has instituted multiple exchange rate systems (Fullerton, 1989b).

To construct the currency index, individual currency weights are calculated as the sum of imports and exports with

each of ten major trading partners and divided by total international trade in each year. Over the sample period, annual trade with Ecuador's top ten import sources and export destinations accounts for more than 70 percent of its total trade volume in any given year. Products of the bilateral trade coefficients and the respective currencies are then used to construct the exchange rate index using a geometric mean. The latter method is selected to avoid problems which can potentially result for indexes constructed using arithmetic means during periods of inflationary variability (see Batten and Belongia, 1986, Dutton and Grennes, 1987, and Kercheval, 1987).

For periods when multiple exchange rates were instituted, a blended index is calculated. Weights for the free-market and official government intervention exchange rates are obtained from the Central Bank publication, **Información Estadística Mensual** (various issues). Econometric results for total and disaggregated imports, and non-petroleum exports indicate that the blended rate provides a more accurate measure of the appropriate currency basket for Ecuador (Fullerton, 1989b). Diagnostic tests were also conducted using currency baskets with different numbers of trading partners.

Introduction of the trade-weighted exchange rate index to Equation 3.7 causes the model to be estimated to take the following form:

$$(3.8) \qquad DP_t = g_0 + g_1DM_{t-i} + g_2DTWX_{t-j} + g_3D(DP_{t-1-k}) + u_8,$$

where TWX stands for logarithmic first differences of the nominal version of the monthly trade-weighted exchange rate index calculated for the sucre by The WEFA Group (formerly Wharton Econometrics). Although incorporation of the monthly exchange rate index avoids the problems associated with implicit price deflator interpolation, it may introduce other problems due to the fact that import prices in Ecuador are affected by global supply and international demand conditions in addition to exchange rate movements (see Fullerton 1993b).

A fourth observation regarding potential pitfalls associated with the theoretical specification of the model is worth noting. Only one class of factor input prices, that for imports, is included. While this represents an improvement over the original Harberger framework, it may overlook additional important inputs such as labor. If the version of the model developed herein omits relevant variables to the inflationary process in Ecuador, it is likely that estimated residuals associated with the empirical version will not be randomly distributed. If this is the case, then correction for serial correlation will be necessary. Extension of the model to overcome this problem cannot currently be accomplished due to data availability.

3.4 Estimation Results

In order to examine whether the working series included in Equation 3.8 are stationary, unit root tests are conducted for each series utilized in the model. Estimation is conducted for the 1964-1994 sample period for which data are available. Applying unit-root tests to what could be considered a relatively short time span may be risky due to the fact that these tests typically have low power unless long-run data sets are used (Hakkio and Rush, 1991). Because time series data in Latin America generally date back to 1957 at most, there is little that can be done to circumvent this potential problem.

Augmented Dickey-Fuller t-statistics are estimated for equations with both intercepts and trends. These results, compared against the corresponding MacKinnon critical value, appear in Table 3.1. In all cases, tests for unit roots in the first differenced log transformed series for consumer prices, money, and the trade-weighted exchange rate index are rejected at the 1-percent level. Based on this evidence, the first-order differenced series used to estimate Equation 3.8 are assumed to be stationary.

As specified, the model is explicitly built around a set of unidirectional causality relations from movements in the regressors to consumer prices. To examine whether the absence of simultaneity in the model is plausible, a set of Granger causality tests are calculated for the stationary components

of the series of interest. These results are reported in Table 3.2 for lags of 6, 12, 18, and 24 months. Tests are conducted for prices and the money supply, as well as prices and the trade-weighted exchange rate.

Similar to the Colombian results reported in Chapter 2, movements in M1 do not appear to be systematically preceded by changes in the CPI in a statistically significant manner at the 5-percent level. Essentially, this implies that monetary policy in Ecuador is conducted in a manner that is not accommodative of price shocks. Although central bank linkages to the executive branch of the government are relatively strong, steps have been taken in recent years to increase both monetary policy autonomy and currency stability (Banco del Pacífico, 1994b).

Implications based on the Granger causality tests estimated for consumer prices and the exchange rate series are less clear. At shorter lag lengths, the null hypothesis that changes in consumer prices do not lead to subsequent changes in the international value of the sucre is rejected at the 5-percent level. This conclusion, similar to the Colombian results obtained by Fullerton (1993c) and Kamas (1995), is not upheld at longer lag lengths and makes it difficult to reach concrete conclusions regarding potential feedback effects between the two series. However, truncation of the longer lag lengths can bias the hypothesis toward incorrect rejection of the null hypothesis (Feige and Pearce, 1979). Consequently,

Table 3.1: Unit Root Tests for Stationarity

Series	Aug Dickey-Fuller t-stat	MacKinnon crit value
P	- 9.778 (with const, trend, 1 lag)	-3.995 (1% lvl)
M	-16.626 (with const, trend, 1 lag)	
TWX	-13.652 (with const, trend, 1 lag)	

Table 3.2: Granger Causality Tests

Causality Direction	Number of Lags	Computed F-stat
CPI => M1	6	1.659
CPI => M1	12	1.309
CPI => M1	18	1.420
CPI => M1	24	1.509
CPI => TWX	6	2.900
CPI => TWX	12	2.214
CPI => TWX	18	1.664
CPI => TWX	24	1.029

a unidirectional channel of influence from exchange rate movements to prices appears to be a reasonable assumption. Given the latter, model estimation is conducted without resorting to instrumental variables, or developing a system of simultaneous equations, and the resulting coefficients are assumed to be unbiased and consistent.

Regression results for Equation 3.8 are summarized here:

$$
\begin{aligned}
(3.9)\qquad DP_t = \; & \underset{(10.224)}{0.015} + \underset{(0.797)}{0.013 * DM_t} + \\
& \underset{(1.735)}{0.028 * DM_{t-4}} + \underset{(2.333)}{0.039 * DM_{t-9}} + \\
& \underset{(5.932)}{0.060 * DTWX_t} + \underset{(0.642)}{0.007 * DTWX_{t-2}} + \\
& \underset{(1.638)}{0.063 * D(DP_{t-6})} + \underset{(8.439)}{0.405 * U_{t-2}} + \\
& \underset{(7.101)}{0.369 * V_{t-1}},
\end{aligned}
$$

R^2	0.379	S.E.R.	0.015	Log likelihood	1013.715
DW	2.087	F-stat	26.798	Prob(F-stat)	0.001,

where the numbers in parentheses are computed t-statistics and V_t is the error term associated with the ARMAX model for U_t. Lag lengths of 24 months were used in the initial estimates for Equation 3.9. While a large number of the resulting coefficients were significant at the 5-percent level, serial correlation was present in the residuals. To avoid potentially spurious estimation results (see Hamilton, 1994), a nonlinear ARMAX procedure is utilized to correct for autocorrelation. This estimator (Pagan, 1974) is useful

because of its flexibility in handling a variety of different error generating processes.

Correcting for serially correlated disturbances caused the computed t-statistics for many coefficients to become insignificant at the 5-percent level. Because inclusion and exclusion of numerous different lags did not yield clear results, the model structure reported in Equation 3.9 was selected on the basis of likelihood ratio tests. Although the relatively short lag components may seem unexpected, they were confirmed by cross correlation function analysis. To handle autocorrelation, an ARMA(2,1) specification is used to characterize the data generating process for the residuals.

As would be expected in an inflationary economy, the algebraic sign of the intercept in Equation 3.9 is positive. Because the model is estimated using differenced data, this result indicates that a systematic upward trend exists in the Ecuadorian consumer price index. As hypothesized by Hanson (1985), the sum of the coefficients for the lagged monetary series is significantly less than one. Similar to Fullerton (1993a, 1993c), but unlike Kamas (1995), the exchange rate appears to play an important role in determining price movements. The coefficient for the velocity of money supply circulation proxy was not, however, significant at the 5-percent level.

Although the sum of the lagged monetary aggregate parameters is less than one, the sum of those coefficients

with the exchange rate variable coefficients does not equal one as implied by the reduced form of the theoretical model specification. These results cast doubt upon the relatively simple version of the Harberger-Hanson framework developed above. As noted previously, this is not completely unexpected and is a potential root cause underlying the presence of autocorrelated residuals in the initial empirical results. To see if the theoretical model can be improved, an alternative version of the approach is currently under development for an economy where data shortages are less severe and a richer input structure can be handled (Kim and Fullerton, 1996). The latter effort will also benefit from the incorporation of an interest rate variable to measure the cost of holding idle cash balances, as well as an import price index rather than the exchange rate proxy utilized herein.

In 1983, the Central Bank introduced new exchange rate policies that allowed the sucre to fluctuate more freely. To allow for potential parameter heterogeneity caused by structural change associated with periodic currency devaluations, a shorter sample was also used for estimation purposes. Results from these exercises, not reported here, generally support the empirical estimates presented above. Experimentation with the lag structure over the shorter sample period does not yield strong evidence of parameter instability or any other major shortcomings with Equation 3.9.

3.5 Policy Simulation Results

From the alternative specification and sample size results, Equation 3.9 does not seem overly fragile. Alternative lag structures and ARMAX processes were compared to the model using likelihood ratio tests to evaluate the results. While it was not possible to reject the specification shown above, it does seem likely, however, that additional time series analysis will be required in order reach firm conclusions regarding inflationary dynamics in Ecuador. For that reason, the modeling and simulation results associated with Equation 3.9 should be regarded as preliminary in nature. They do, however, provide a good starting point for understanding short-term Ecuadorian price movements and assessing government policy objectives.

Cognizant of the paucity of comparative research results in this segment of the literature, a variety of simulation experiments are conducted using Equation 3.9. The goal of the simulation tests is to shed light on the feasibility of attaining the inflationary stabilization targets announced by the Durán Ballen-Dahik Garzozi administration in 1995. Sample data used to estimate Equation 3.9 only includes information available to government policy makers at the time the inflation target was announced. The simulation analyses thus satisfy the Klein (1984) and Christ (1993) criteria for forecast evaluation. Of course, additional policy analysis with different model specifications may also be useful.

To examine the feasibility of the government's inflation goals, four simulation exercises are conducted using Equation 3.9. The first exercise assumes immediate implementation of price stabilization plan wherein the annualized rate of growth in the money supply and the rate of devaluation are reduced to 20 percent within one month of the policy announcement. Scenario two examines rapid implementation of the price stabilization whereby growth in the money supply and the rate of devaluation are reduced to 20 percent over a 6-month phase-in period. The third simulation test analyzes the effects of gradual introduction of the anti-inflationary program with money supply growth and the rate of devaluation lowered to 20 percent during a 12-month period. The rates of money supply growth and currency depreciation reflect the revised policy targets adopted following the border conflict with Perú and the aftermath of the "Tequila effect" associated with Mexico's December 1994 peso devaluation (Banco del Pacífico, 1995).

Policy simulation results are reported in Table 3.3. The impacts associated with all three implementation scenarios are striking. In each, reducing the rate of money supply growth and slowing the rate of nominal currency depreciation to 20 percent over a one-to-twelve month implementation period causes inflation to decline to less than 25 percent. This is somewhat close to the policy target established by the government in late 1994. If implementation of the stabilization program is immediate, annual consumer prices

increases fall to slightly more than 23 percent. In a more likely scenario under which intermediate policy targets are attained more gradually, disinflation is still fairly rapid and overall policy credibility would not appear to be at risk. To actually achieve the announced inflation target, however, does not appear likely.

The final column of Table 3.3 contains the results associated with a scenario in which no progress is made with respect to lowering the rate of growth in the money stock. Similarly, nominal depreciation of the sucre is not lowered under this simulation. In contrast to the "no implementation" policy simulation results reported in Table 2.7, the inflation rate remains practically unchanged if no intermediate steps are taken by Ecuadorian monetary authorities. This result is due in large part to the fact that consumer prices in Ecuador rose on average by approximately 26.7 percent per year during the past three decades. As a result, the policy experiments illustrated in Table 3.3 have a common starting point that is almost identical to the sample period mean.

On the basis of the empirical evidence obtained in this chapter, it appears that Ecuador's anti-inflationary program is fairly credible. This conclusion is predicated upon eventual deceleration in the rates of liquidity growth and currency depreciation brought about by the central bank. In light of previous monetary policy analysis conducted for

Table 3.3: Policy Simulation Results

Month	Immediate	Rapid	Gradual	None
1	26.1	26.2	26.2	26.2
3	24.9	25.1	25.3	26.0
6	24.3	24.8	25.1	25.8
9	24.0	24.5	25.1	25.9
12	23.2	23.7	24.2	26.0

Ecuador, the results obtained are pleasantly surprising (Fullerton, 1990a, offers a negative assessment of an earlier price stabilization effort). That the government's announced targets are not completely attained is in line with other studies of Latin American inflation policies (Fullerton, 1993c, and Kamas, 1995).

3.6 Conclusion

An empirical model of Ecuadorian consumer price inflation is developed and estimated in this chapter by incorporating both monetary and import cost effects in a theoretically plausible manner. Specification and simulation of the model are relatively easy to accomplish. Experimentation with the estimated equation indicates that the current anti-inflationary goals of Ecuadorian monetary authorities are in large part attainable. Because the model does not pose stringent data requirements, it may be applicable to other Latin American economies where inflation remains a problem. Examples include Brazil, Colombia, Mexico, and Venezuela where authorities continue to grapple with short-term price stabilization goals.

Additional econometric testing should prove useful. Initial results reported above indicate this framework will likely benefit from incorporating a more realistic conceptual model. Because ARMAX treatment of nonrandom movement in the initial model residuals was necessary, expansion of the scope

of the model to include additional factors such as labor costs may be required to more completely specify the inflationary process in Latin America. Doing so, however, may necessitate the usage of instrumental variables or the introduction of multiple equations which allow for potential endogeneity between prices, money, import costs, and wage rates. Even if the latter are not required for parameter estimation consistency, they could enrich subsequent policy simulation analyses.

These suggested changes represent avenues for refinement to the basic model outlined above. They are not likely to result in wholesale alterations to the general framework. Similarly, it is not clear that policy simulation impacts and conclusions will change markedly due to expanding the scope of the empirical techniques presented above. But given the breadth of economic conditions prevailing across Latin America, steps in these directions may prove helpful to subsequent econometric research of this nature. Given the divergence between the theoretical model parameters and the estimated coefficients, additional empirical testing is certainly warranted.

CHAPTER 4
PREDICTABILITY OF SECONDARY MARKET DEBT PRICES

4.1 Introduction

While inflation has undoubtedly been one of the most hotly debated items in Latin American policy debates, issues related to external obligations have also been important topics of discussion in the region. Following the outbreak of the international debt crisis in September 1982, a secondary market for sovereign debt instruments became active in the major world financial centers. As the payments crisis spread from Mexico to the rest of Latin America, much of Africa, and parts of Asia, secondary market trades in developing country sovereign debt paper increased. Key issues in the emerging debate regarding potential solutions to the payments problem often involved the treatment of discounts from face value implied by secondary market debt prices.

Accordingly, researchers began investigating different aspects of the behavior of secondary market developing country debt prices. Much of this work investigates the applicability of theoretical valuation models to assessing implied discounts from face. Other research has used secondary market prices and other financial data to evaluate the probability of payment rescheduling requests. Authors have also attempted to

assess the sensitivity of the secondary market to macroeconomic fundamentals, but these efforts have not investigated whether or not the discounts from face value on these obligations are predictable.

Several basic questions are investigated in the chapter at hand. An important issue to be considered is the nature of the time series behavior of these prices. Under certain conditions in an efficient market, each individual series might be expected to follow a random walk. Of course, in a relatively thin secondary market such as that for developing country debt, the perfectly competitive hypothesis may not always be satisfied. If movements in the price series are nonrandom, it may be possible to relate these variations to changes in other domestic and international economic indicators which are generally included in commercial forecasts of the region. Candidate series which help assess creditworthiness include variables such as interest rates, export prices, and international reserves (see Fullerton, 1991, 1993a).

Anecdotal evidence indicates that countries with good payments records such as Colombia have seen their access to international commercial credit diminish over the last fifteen years. If the "good debtor in a bad neighborhood" contagion effect is present, this will be manifested in the movements of the discounted prices. Debt prices for individual countries would consequently be affected by developments in neighboring

countries and correlated with the prices for the instruments of those economies and the market in general. The generalized least squares estimation procedure used below implicitly takes this possibility into account by allowing for contemporaneously correlated residuals across equations.

To examine the predictability of these series, forecasts are generated using jointly estimated individual country models. For comparison purposes, baseline projections are developed using the random walk assumption that the best forecast is one of no deviation from the last observation available in each data set. Modified Theil U-coefficients are then calculated on the basis of root mean squared error (RMSE) ratios estimated for each set of model based and random walk forecasts. The U-statistic for an individual forecast step-length is equal to the ratio of the model based RMSE to that of a no change RMSE. When the resulting coefficient is less than one, the equation forecast has outperformed the random walk prediction.

4.2 Earlier Studies

There have been a growing number of studies regarding developing economy external indebtedness and the secondary market in recent years. Gennotte, Kharas, and Sadeq (1987) develop a numerical debt valuation method based on a financial options pricing technique. Using liquid international reserves plus the estimated values of the capital stocks in

mining and manufacturing as proxies for collateral in each country, theoretical values for developing country foreign debts are simulated under different scenarios involving interest rate changes, principal due, and front-end fees. Simulation results are found to be positively correlated with secondary market prices reported for 1985.

Stone (1991) examines the behavior of implied returns on secondary market sovereign debt instruments. Using an arbitrage pricing model approach, he examines the empirical relationships between secondary market returns and various macroeconomic variables. To control for cross equation disturbance simultaneity, a seemingly unrelated regression estimator is utilized. Poor equation fits and weak t-statistics indicate that movements in implied sovereign debt returns are not readily explained by arbitrage pricing techniques.

Other empirical studies of sovereign debt problems have been more successful. Rahnama-Moghadam and Samavati (1991) employ probit models to examine the propensity to default. Ten different macroeconomic and international financial ratios are used to quantify the probability of rescheduling. Among the ratios found most useful in predicting debt moratoria, formal or informal, are the following: international reserves relative to imports of goods and services; international reserves to disbursed debt; disbursed debt relative to exports; disbursed debt to gross domestic product; and

interest payments relative to exports of goods and services, also known as the interest service ratio. Parameter estimates are based on annual cross country sample data from around the globe.

The probit results discussed in the preceding paragraph were later confirmed by subsequent research which utilized data from Latin American economies (Rahnama-Moghadam, Samavati, and Haber, 1991). Reasons offered for segmenting the data in this fashion include geographic, structural, and institutional similarities among countries in Latin America. The authors also point out that economies in this smaller sample are all middle-income countries which share similar characteristics in terms of overall development. The models exhibit relatively high goodness-of-fit statistics, individual coefficients with expected algebraic signs, statistically significant parameter estimates, and coefficient stability across different specifications. As debt problems arise from a number of different determinants, it would appear that a further refinement from a regional focus to that of an individual economy may be useful.

The roles of fundamental economic and financial factors in the evolution of secondary market sovereign debt prices have been directly examined in recent research. As shown by Anayiotos and de Piniés (1990), these types of characterizations are straightforward and intuitively appealing. In a statistical framework, variables selected to

capture market fundamentals can also be combined with regressors designed to represent exogenous risks. Using pooled observations and annual data, the econometric results of these authors show that even simple specifications can represent secondary market developing debt prices with a high degree of accuracy.

Perasso (1989) also emphasizes economic factors in his study of secondary market prices. To reflect the importance of debt-equity conversions, his pricing model is derived from a profit maximizing framework that includes real interest rate measures, real costs of capital, international wage differentials (assumed to induce manufacturers to invest abroad), and individual economy performance variables. Time series and cross country annual data are pooled prior to estimation. Some coefficients are statistically insignificant or of the wrong sign, but overall empirical results for the estimated equations for secondary market prices are fairly strong.

Empirical models developed by investment bankers indicate that secondary market debt prices can be modeled and forecasted (see Purcell and Orlanski, 1988, 1989). Similar to the studies mentioned above, these models also rely upon pooled cross section time series data for different countries. Regressors used to estimate equation parameters include debt to export ratios and per capita incomes. Dummy variables for payment rescheduling programs, principal payment moratoria,

and debt retirement agreements are also entered as right-hand side variables. Model simulations using individual country data are used to calculate specific secondary price forecasts.

As mentioned previously, not all of the statistical evidence with respect to the behavior of secondary market prices leads to the same conclusions. Laney (1987) concludes that economic factors are more important as explanatory variables than political and structural risk factors. Sachs and Huizinga (1987) report regression results that indicate both economic and political variables have key roles to play in modeling developing country debt discounts. Similar to other studies, the latter also utilize pooled cross country data in calculating equation parameters.

4.3 Empirical Analysis

As the literature review indicates, there have been a variety of studies with interesting econometric results published in recent years. However, none of the initial efforts attempted to model secondary market debt prices for individual countries using time series sample observations. Given the differing sources of debt servicing difficulties, a country by country examination of secondary market price movements appears warranted. Similarly, individual forecasting models or equations have not been systematically tested to examine whether debt prices can be predicted with any degree of accuracy. Despite the fact that financial

market participants focus almost exclusively on short-term movements in sovereign debt prices, earlier research efforts also failed to study high-frequency data from this market.

In this section of the chapter, simple forecasting models are proposed, estimated, and simulated for three individual debtor countries. These equations are modeled jointly using monthly data series. As stated in the introduction, modified Theil inequality coefficients are calculated using random walk forecasts as the benchmarks to which the model projections are compared. Although the individual equation specifications employed are straightforward, recent financial market research underscores the potential success of simple forecasting models (see Granger, 1992, and Christ, 1993). This initial attempt provides a useful starting point for addressing questions regarding the predictability of secondary market developing country debt prices.

Debt price data used in the empirical estimates are collected by Salomon Brothers in New York, with monthly averages published by The WEFA Group in Philadelphia. The sample period is March 1986 - December 1991. Countries included in the sample are Colombia, Ecuador, and Venezuela. These countries have interesting and differing histories with respect to their external debt management practices and their individual approaches to economic policymaking in general.

Colombian debt management practices have traditionally been more conservative than those of either of its neighbors.

Government economists have consistently treated international credit markets as sources of financing to bridge domestic savings gaps (Fullerton, 1990b). Colombian debt negotiators have never sought a Brady initiative write-off, arguing that to do so would only impair the nation's creditworthiness. Over the period from 1945 forward, Colombia has never declared an interest payment moratorium and has one of the best debt service records among developing countries which have utilized external financing sources.

Ecuador declared principal and interest moratoria in 1987 as a result of the financial aftermath following the earthquake which shattered the country's transAndean oil pipeline. The latter event interrupted Ecuador's principal source of export earnings and destroyed much of its physical infrastructure. In 1989, the Borja administration resumed negotiations with commercial creditors and eventually began honoring 30 percent of the interest coming due on commercial loans (Fullerton, 1989c). Progress regarding the treatment of growing amortization and interest arrears remained elusive through the balance of the Borja government which stepped down in 1992. A new round of discussions with Ecuador's bank advisory committee began after the Durán Ballen-Dahik Garzozi government took office.

Venezuela also encountered debt service problems following negative oil price shocks in 1986 and 1988. Eventually, the Perez administration rescheduled commercial

credits under a Brady initiative agreement with Venezuela's bank advisory committee (Fullerton, 1990c). The agreement offered bank loan syndicate members five menu options designed to relieve balance of payment pressures faced by this economy. Several Euromoney bond issues were successfully floated in subsequent periods and Venezuela temporarily regained access to international credit markets.

Debt instruments for all three countries have traded at substantial discounts from face value in recent years. Given its superior service record, it is not surprising that Colombian paper generally carries a higher price than that of its two Andean neighbors. Similarly, given its higher level of payment arrears and worse economic performance, Ecuadorian paper tends to trade at sharper discounts than those of the other countries in the sample.

Table 4.1 presents summary statistics for each secondary market sovereign debt price series. Discounts from face value on Colombian debt certificates were less variable than those of Ecuador and Venezuela during the March 1986 - December 1991 sample period. The range and standard deviation for Colombian debt quotes are smaller than the others, while those for Ecuador are the largest of the three. The arithmetic means for each series follow the opposite pattern in terms of ranking. Data in Table 4.1 are in cents per dollar, or percent of face value of the loans, the units in which transactions are conducted at money center trading desks.

Table 4.1: Secondary Market Debt Price Summary Statistics

Country	Average	Maximum	Minimum	Standard Deviation
Colombia	69.990	86.00	50.00	10.415
Ecuador	30.332	68.00	10.67	18.728
Venezuela	57.635	78.50	31.50	14.859

The sample period is March 1986 - December 1991.

Each series is modeled as a function of key economic and financial variables which are easily observed as well as likely to be used by secondary market participants as indicators of the creditworthiness of the individual country. Possible regressors include lagged debt quotes, world interest rates, commodity export prices, international reserves, and domestic price indexes (for discussion, see Wakeman-Linn, 1991). As mentioned above, series such as these are typically included in macroeconometric forecasting models of Latin America due to their usefulness in predicting balance of payment movements and general economic performance (see Fullerton, 1993a, 1993b).

A three-stage generalized least squares (3SLS) regression technique is used to jointly estimate model parameters (Zellner and Theil, 1962). Doing so permits incorporating potential cross-equation simultaneity effects of events such as Citibank's decision to unilaterally increase loan loss reserves in 1987. The latter is believed to have reduced overall secondary market liquidity and also reduced the attractiveness sovereign debt paper to most creditors, irrespective of their individual payment records (Gajdeczka and Stone, 1990, and Snowden, 1989). This estimator also allows for potential simultaneity between the dependent variables and the independent variables. In the case of Ecuador, this is important because feedback exists between the secondary market debt price and the 180-day LIBOR.

Individual models may be written conceptually as:

4.1 $p_t = b_0 + b_1x_{1t} + \ldots + b_nx_{nt} + e_t,$

where p_t is the secondary market sovereign debt price series for an individual country at time period t, $x_{1t}, \ldots, x_{nt}$ are predetermined domestic and international variables for each economy, e_t is a random disturbance term, and $b_1, \ldots, b_n$ are regression coefficients. From a theoretical modeling perspective, this approach may seem informal. Two points are relevant.

First, alternative methodologies were originally considered but deemed inappropriate due to data requirements and difficulties in applying them to forecasting problems (Fullerton, 1990d). Second, the complete absence of other studies of this nature increases the value of an initial attempt to establish whether any regularities at all are present in the data (Christ, 1994). Both points were repeatedly raised by financial economists who participate in the secondary market and attended the Sovereign Debt Conference sponsored by The WEFA Group in New York in 1990. Similar observations are also made by Friscia (1993).

As mentioned above, parameter estimation is accomplished using the 3SLS methodology developed by Zellner and Theil (1962). Other procedures were considered, but 70 monthly observations constitutes a fairly small sample for many time

series estimators. The series are not differenced prior to estimation, but are logarithmically transformed. Because the data are in levels, it is important to assess whether the series are cointegrated. The latter assumption is tested via unit-root tests on the individual model residuals (for discussion, see Hamilton, 1994).

Because monthly data are used, it is not possible to utilize the same regressor variables as have been used in earlier studies incorporating quarterly or annual series from national income and product accounts. There are still a number of potential candidate series which the financial community may use as indicators of a country's creditworthiness and will potentially influence secondary market price quotes. It should be noted that sets of indicators will vary for different countries according to individual economic endowments and performance records. This argument is similar to that previously made for equations used to estimate developing country borrowing levels under different regimes (Eaton and Gersovitz, 1981).

For Colombia, Equation 4.2 in Table 4.2, the regressors include a one-month lag of the debt price, the effective annual rate for the 180-day London interbank offer rate (LIBOR), and the one month change in the national consumer price index (CPI). The one-month lag on the debt price is included to provide information on how the market has valued Colombian paper in the most recent period. International

loans to sovereign nations typically carry variable interest rates defined in terms of a fixed spread over the 6-month LIBOR. Upward changes in the variable interest rate assessed on such loans will reduce Colombia's current account balance and exert downward pressure on secondary market prices. The rate of inflation is used as a proxy for overall economic conditions. When inflation rises, Colombian monetary authorities generally attempt to tighten credit conditions (Fullerton, Fainboim, and Agudelo, 1992). Parameter estimates for each variable have the expected arithmetic signs, but the t-statistic for the inflation term is not significant at the 5-percent level.

In the case of Ecuador, Equation 4.3 in Table 4.2, only two predetermined variables are included in the three-staged least squares equation. The first is a one-period lag of the secondary market debt price series. The second is the 6-month LIBOR rate. These series are included for the same reasons as they were used in the Colombian equation. Both coefficients have the expected signs and are statistically significant. The absence of other balance of payment indicator series such as export prices may seem surprising. Because Ecuador, similar to Colombia, has a relatively diverse commodity export basket, no single price series will suffice (Fullerton, 1993a, 1993b). This is not the case for Venezuela, where petroleum products account for more than 80 percent of total merchandise exports (Fullerton, 1990c).

Table 4.2: Three-Stage Least Squares Regression Results

4.2 Colombia

$$P_t = \underset{(3.467)}{1.142} + \underset{(15.946)}{0.818*P_{t-1}} - \underset{(3.128)}{0.172*LIBOR6M} - \underset{(1.735)}{0.916*CPI_t}$$

R^2	0.951	SER	0.034	F-stat	366.471
Q(6)	6.118	Q(12)	8.848	Prob(F-stat)	0.001

4.3 Ecuador

$$P_t = \underset{(3.376)}{1.352} + \underset{(26.893)}{0.883*P_{t-1}} - \underset{(3.227)}{0.476*LIBOR6M}$$

R^2	0.981	SER	0.088	F-stat	1462.68
Q(6)	5.632	Q(12)	7.803	Prob(F-stat)	0.001

4.4 Venezuela

$$P_t = \underset{(2.765)}{0.972} + \underset{(16.132)}{0.811*P_{t-1}} - \underset{(2.529)}{0.249*LIBOR6M} + \underset{(1.735)}{0.061*IR_t} + \underset{(2.508)}{0.072*OIL_t}$$

R^2	0.959	SER	0.057	F-stat	319.777
Q(6)	3.717	Q(12)	5.671	Prob(F-stat)	0.001

The sample period is March 1986 - December 1991.

Four independent variables are included in the Venezuelan model. As shown in Equation 4.4 in Table 4.2, they include a one-period lag of the debt price, the 180-day LIBOR series, international reserves net of gold, and the average price of petroleum exports. International reserves and the oil export price are employed as proxies for expected economic conditions in Venezuela. Although related, the two series do not always follow parallel paths. More specifically, the level of international reserves serves as an indicator of domestic economic policy success or failure (Fullerton, 1990c). World oil prices provide a measure of global demand for the nation's principal export. All of the regressor coefficients have the expected signs. The t-statistic for international reserves, however, is not significant at the 5-percent level.

The 3SLS technique utilized to estimate the parameters reported in Table 4.2 allows for potential cross equation contemporaneous error correlation, a reasonable assumption for the secondary market for sovereign debt paper. To examine whether this assumption is necessary, residuals from the first stage ordinary least squares (OLS) regression are tested for contemporaneous correlation using a standard t-test methodology (see Ostle and Mensing, 1975, or Snedecor, 1956). As shown in Table 4.3, the OLS residuals for Colombia and Venezuela are correlated in a statistically significant manner, as are those for Ecuador and Venezuela.

Table 4.3: OLS Cross Equation Correlation Coefficients

Equation Residuals	Correlation Coefficient	Computed t-stat
Colombia-Ecuador	0.101	0.772
Colombia-Venezuela	0.340	2.750
Ecuador-Venezuela	0.453	3.872

Unit-root cointegration tests performed on the individual country 3SLS residuals are reported in Table 4.4. In all three cases, it appears cointegrating vectors have been obtained. Note that this procedure may be inappropriate for the short data set which currently exists for secondary market developing country debt prices. Previous research has shown that tests associated with unit-root techniques have low power when applied to short-run data sets (Hakkio and Rush, 1991). For purposes of the chapter at hand, the results in Table 4.4 are interpreted as evidence that the 3SLS regression results are not spurious. Given the diagnostic statistics also reported in Table 4.2, the latter conclusion is probably reasonable.

To conduct ex ante dynamic simulation exercises, the equations were jointly reestimated and simulated for 24 different historical subperiods. Four month ahead forecasts were produced for each secondary market debt price series from the last subperiod observation forward. A four-month step length is sufficient to incorporate quarterly portfolio accounting considerations faced by international banks. As pointed out by participants at the 1990 Sovereign Debt Conference, quarterly corporate income tax filing requirements often trigger loan certificate swaps between secondary market participants and make a four-month time frame logical for simulation experiments.

Table 4.4: Unit Root Cointegration Tests

Country	Aug Dickey-Fuller t-stat	MacKinnon crit value
Colombia	-4.895 (with const, trend, 1 lag)	-4.122 (1% lvl)
Ecuador	-5.140 (with const, trend, 1 lag)	
Venezuela	-5.320 (with const, trend, 1 lag)	

To further enhance the realism of the extrapolation scenarios, actual forecast data available to the financial markets during each of the 24 subperiods are incorporated in the simulations. By relying on forecast data which are unconditional upon any information not available prior to the start of any simulation period, Klein's (1984) forecast evaluation criterion is met. These estimates for the independent regressors were compiled from international outlook reports published by The WEFA Group from 1989 to 1991.

Forecast results for each price series are summarized in Table 4.5. For Colombia, the results indicate that the secondary market LDC debt price series is predictable using econometric methods. Although the 1-month ahead Colombian projections have a slightly greater than unity U-coefficient, the remaining estimates are all less than one. Interestingly, the Colombian inequality coefficients monotonically decrease as the length of the forecast period increases. This suggests that inclusion of econometric information, in this particular instance, grows in importance as the timeframe under consideration expands.

In the case of Ecuador, the results reported here suggest that its secondary market debt discount is unpredictable. Consequently, it appears that financial analysts can do no better than utilize the last available observation for Ecuadorian paper in anticipating future quotes. Additional research with alternative estimators and different

Table 4.5: Modified Theil Inequality Coefficients

Series	1 Step	2 Steps	3 Steps	4 Steps
Colombia	1.070	0.888	0.728	0.611
Ecuador	1.715	2.109	2.408	2.614
Venezuela	1.263	1.207	1.108	1.017

The simulation period is January 1990 - December 1991.

specifications might obtain superior forecast accuracy, so it may be premature to conclude that the Ecuadorian debt price series is not predictable. As presented above, however, the results obtained in this chapter provide a fairly striking example of the fact that a relatively high coefficient of determination does not guarantee automatic simulation accuracy.

Forecasting results for the Venezuelan debt price series are also interesting. Similar to Colombia, the inequality coefficients decline monotonically as the length of the projections increases. Unlike the Colombian example, however, the Venezuelan U-statistics remain at least slightly above unity at each step length. On the basis of the results in Table 4.5, it therefore appears that a random walk approach yields better forecasts. Experimentation with other estimators is probably warranted. Similar to Ecuador, however, the Venezuelan modeling and simulation results provide another example of a case in which a high coefficient of determination does not guarantee prediction accuracy.

4.4 Conclusion

A simple questioned is asked in this chapter. Are secondary market debt prices predictable? To shed light on the possible answer, several steps are taken which have not previously been investigated. A key aspect that distinguishes this research from earlier efforts is the modeling of monthly

time series data for individual economies, as opposed to cross section annual or quarterly samples used elsewhere. Also developed are forecast exercises designed to meet the needs of participants in international financial markets where developing country debt instruments are traded.

Modeling and simulation results reported here provide only limited evidence that it is possible to forecast secondary market developing country debt discounts from face value. All three series in the sample exhibited interesting model characteristics. In particular, the equations and forecasts for Colombia are encouraging. The same cannot be said of the Ecuadorian and Venezuelan prediction tests, as in both cases simple random walk forecasts of the respective debt price series prove more accurate.

Because the three economies, and their respective debt price series, differ substantially from one another, it may be useful to apply this modeling approach to other debt price series. Obvious candidates include Argentina, Brazil, Chile, Mexico, and Perú. Further specification enhancements for Ecuador and Venezuela may also provide useful information.

Inclusion of institutional variables related to Brady-initiative debt negotiations might prove beneficial, especially if it is possible to construct monthly indices for these factors. As noted by Friscia (1993), however, confidentiality restrictions may preclude this possibility.

Similarly, it may be worthwhile to test alternative estimators. The latter will become more feasible as additional observations and information regarding this market become available. On balance, however, it appears that movements in secondary market debt prices are not predictable.

CHAPTER 5
SUGGESTIONS FOR FUTURE RESEARCH

In Latin America, short-term econometric forecasting analysis is still a largely uncharted area of research. Material presented above indicates that a variety of techniques, methodologies, and modeling approaches may yield interesting insights with respect to both forecasting and policy issues. Not surprisingly, this research has only hinted at a few of the potentially beneficial topics which merit further attention.

As discussed elsewhere, the availability of low cost computer hardware and software, plus the development of wide coverage high-frequency data banks, will help encourage additional research of this nature (Fullerton, 1992). With respect to the results presented above, new efforts are already underway in terms of alternative estimators for secondary market debt price forecasting. The underlying theoretical model presented in Chapter 3 has also been extended to include labor costs as part of the price vector on the output side for studying price dynamics.

From a business forecasting perspective, a promising area of endeavor is likely to arise from the publication of quarterly national income and product account data. In

countries such as Ecuador, this will permit the development of large-scale macroeconometric models such as those pioneered by Barger and Klein (1954). The latter continue to enjoy a central role in business and government planning exercises throughout the world. Given the short-term uncertainties present in Latin America, quarterly modeling and forecasting will likely be welcomed with enthusiasm. At this juncture, much work remains to be done, but initial efforts such as those presented above point to numerous potential successes to be gained from future research efforts.

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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